Monitoring Salt Marsh Elevation at Cape Cod National Seashore: Understanding the response to sea level rise

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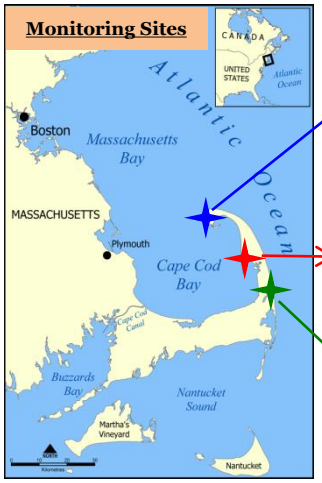
BACKGROUND

Tidal marshes are critical coastal resources at Cape Cod National Seashore (CACO) and throughout the northeastern United States. Salt marsh integrity and the ability of marshes to build vertically are impacted by human activities such as dikes or other tidal restrictions, which alter natural sediment transport patterns and can contribute to the loss of salt marsh habitat.

Salt marshes must also keep pace with changes in sea level. Salt marshes that are located at the high end of their growth range are said to have "higher elevation capital" since they are buffered from changes in sea level due to their higher elevation. Salt marshes near the bottom of their growth range are said to have "low elevation capital" since they are very susceptible to increases in sea level rise and increases in flooding frequency. If a marsh cannot keep pace with sea level rise, it may convert to intertidal mudflats or sub-tidal open water habitat.

To understand the response of salt marshes to sea level rise and to impacts of tidal restriction, Cape Cod National Seashore has been monitoring surface elevation change using the Surface Elevation Table (SET) for 15 years. Water levels were also measured to determine the tidal regimes and GPS data was collected to determine the surface elevations of the marsh and adjacent waters.

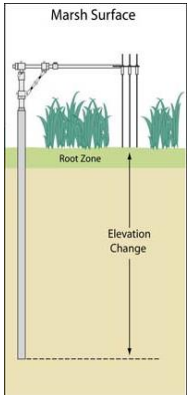


Hatches Harbor (HH)

Herring River (HR)

Nauset Marsh (NM)

METHODS



1- Marsh surface elevation change (mm/yr):

The Surface Elevation (SET) method is used to monitor change in tidal marshes globally.

It is used for long term measurements of the marsh surface and provides measure of change of the surface in mm/yr over time.

2- Tidal Datums (m):

Tidal datums were calculated by measuring water levels using a HOBO water level logger deployed in a PVC pipe stilling tube.

3- Marsh elevation (m) – GPS survey:

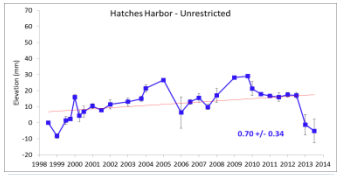
The elevation of the marsh surface and the water level loggers were measured using a Trimble VRS GPS system.

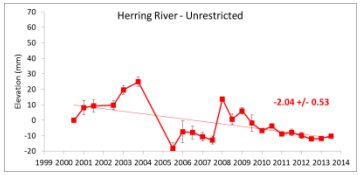
RESULTS

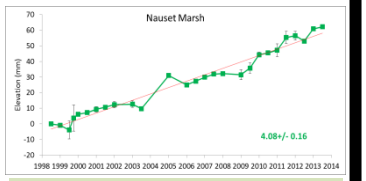
Precise measures of sediment elevation in wetlands are necessary to determine rates of elevation change, particularly relative to sea level rise, and to gain an understanding of the processes responsible for elevation change.

Are CACO marshes keeping pace with sea level rise?

Long-term Sea Level Rise Rate (Boston)
2.79 mm/yr







- Overall rate of **0.70 mm/yr** is slower than long-term sea-level rise
- Marsh surface floods twice a day
- Low elevation capital (low relative to MHW and lower in growth range)

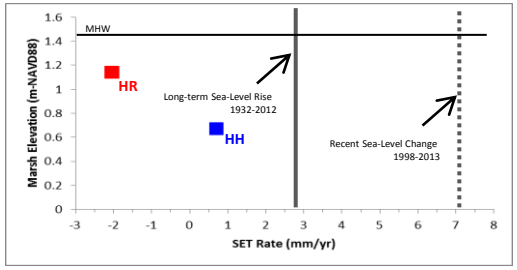
- Marsh is subsiding at a rate of **-2.04 mm/yr**
- Marsh surface floods only during spring tide events
- High elevation capital (higher in growth range)

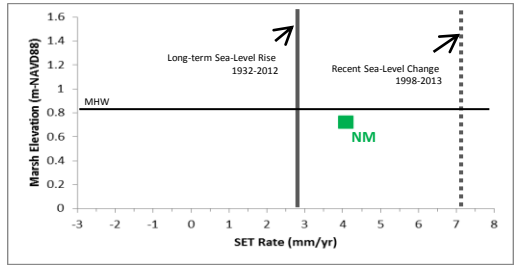
- Overall rate of **4.08 mm/yr** is keeping pace or even exceeding long-term sea-level rise
- Marsh surface floods only during spring tide events
- High elevation capital (higher in growth range)

- It is important to note that **Recent Sea Level Change** (7.2 mm/yr) calculated from the Boston water level data from 1998 to 2013 is considerably greater than the 80 year long record from the published **Long-term Sea Level Rise Rate** (2.79 mm/yr).

- Salt marshes can tolerate a short-term deficit in elevation relative to the rate of sea level change, but over the longer-term, marshes need to keep pace or may convert to wetter conditions.

Site	Marsh Elevation (m-NAVD88)	Elevation Change (mm/yr)	Tidal Range (m)	Tidal Datum MHW (m-NAVD88)
HH	0.67	0.7	1.29	1.53
HR	1.14	-2.04	2.51	1.45
NM	0.72	4.08	0.79	0.81





SUMMARY

- Elevation change in three tidally unrestricted marsh systems at Cape Cod National Seashore has been highly variable over the last 15 years.
- Only Nauset Marsh is keeping pace and even exceeding the long-term rate of sea level rise.
- Marshes at Hatches Harbor and Herring River are not keeping pace with long-term sea level rise and show very little or even negative changes in elevation over time.
- The negative rate of elevation change in the Herring River marsh may be a result of bio-turbation and change in hydrology due to crab herbivory and salt marsh dieback within the system.
- The recent sea level change is considerably greater than the rate of surface elevation change at all three marshes.
- Overall, the marshes that are low in the intertidal zone and near the bottom of the growth range, may be more vulnerable than those marsh platforms that are higher in the intertidal zone.